Space Weather Technical Forecast

Issued on Thursday, 01 February 2024 at 13:26 Local

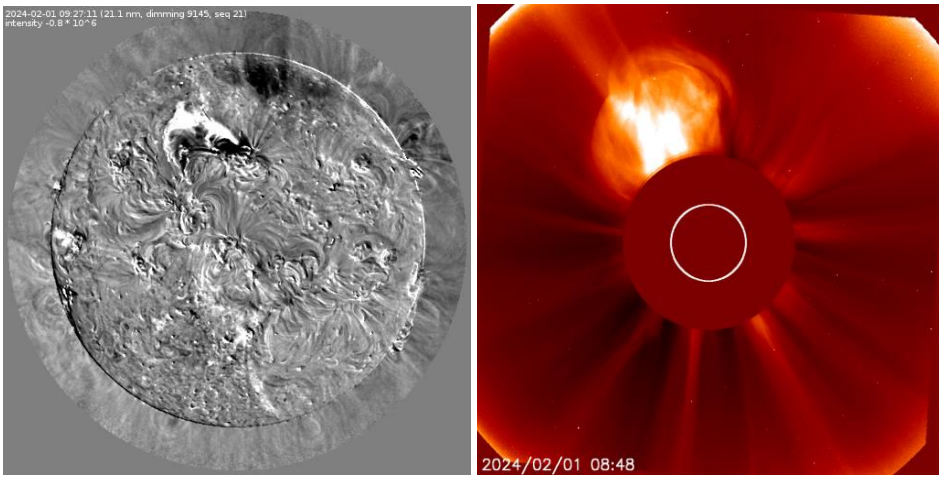
This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated R1/R2 Radio Blackouts. High speed stream from a coronal hole possibly arriving by day 4 (Feb 04).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with a long duration C3 flare, peaking at 01/0743 UTC, which appears to be associated with a surge from an area of enhanced flux in the northern hemisphere. This produced a CME, which is yet to be analysed for any potential Earth-directed component. There are currently ten sunspot regions on the visible disc, two of which are noteworthy and two of which are yet to be numbered. AR3567 in the northeast remains the largest and most magnetically complex region on the disc, with continued growth whilst maintaining a delta configuration on the main lead spot. AR3565 in the northeast is the only other spot showing some magnetic complexity and increase in areal extent, this spot still comprises a north-south magnetic alignment in its leading portion, which also contains a delta spot. The remaining sunspot regions appear to be small and stable, or in decay, especially the region in the western hemisphere. Another new sunspot region appears to be emerging from around the east limb.

Figure 0 – Solar dimming (left) associated with the long-duration C3 flare at 0738 UTC on 01 Feb in an area of enhanced flux, which produced a CME (right) seen in LASCO imagery. Pending analysis for any potential Earth-directed CME.



A glancing blow from a CME which left the Sun on the 29 Jan arrived at Earth at 01/0520 UTC, although very little impact has been observed, with geomagnetic activity remaining Quiet. A single CME was also observed leaving the western limb shortly after midday on 31 Jan. Although the source of which is still not certain, after computation, it appears to be missing behind Earth. No other Earth-directed CMEs have been observed in the past 24 hours.

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Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, were indicative of a weak and waning coronal hole high speed stream, from slightly elevated to slow-ambient levels, before rising again to slightly elevated levels, due to the arrival of a weak CME (which left the Sun on 29 Jan). Wind speeds ranged from 390 to 460km/s throughout the period, currently declining to background levels as the weak CME passes. The solar wind density was average to below average throughout, despite the arrival a weak CME. The interplanetary magnetic field (IMF), Bt, was mostly weak, but briefly rose to moderate, peaking at 8nT following the CME arrival, with the north-south component, Bz, varying weakly, reaching +5 to -6nT. The Phi angle was predominantly negative (towards the Sun). The net result of the above solar wind measures was Quiet geomagnetic activity (Kp 0-2), despite the weak CME arrival.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is currently at slightly elevated levels following the M6.8 flare on 29 Jan from EX-AR3559, but remains well below the S1/Minor Storm threshold and continues to gradually decline.

GOES16 high energy (greater than 2MeV) electron flux was at normal background to moderate levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold but on a rising trend. At 01/0000 UTC the 24-hour integrated fluence observation was 2.87e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low, but with a chance of increasing to Moderate with isolated M-class flares, most likely from AR3565 or AR3567.

Solar Wind / Geomagnetic Activity: Solar winds are gradually declining to background levels following a weak and glancing blow from the CME (which left the Sun on 29 Jan) and the waning effects of previous coronal hole fast wind. A further CME from the 31 Jan may give a glancing blow at Earth either on day 3 or 4 (03-04 Feb), although this is low confidence. The next anticipated HSS enhancement is from CH96/+ in the southern hemisphere, the bulk of which is expected to be on day 4 (04 Feb), with solar wind speeds reaching 450-500 km/s. Despite the arrival of a weak CME early on day 1 (01 Feb) geomagnetic activity has been Quiet, and is expected to remain Quiet during days 1-3 (01-03 Feb). There is a chance for isolated Active intervals on day 4 (04 Feb), due to the influence of CH96/+. Also, pending the analysis of the CME launched early on day 1 (01 Feb).

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain below the S1/Minor Radiation Storm level, with a nominal risk of exceeding the S1 threshold during the period.

The high energy electron flux (greater than 2MeV) is expected to remain below High levels throughout the period, with exceedance of the Active threshold considered extremely unlikely.

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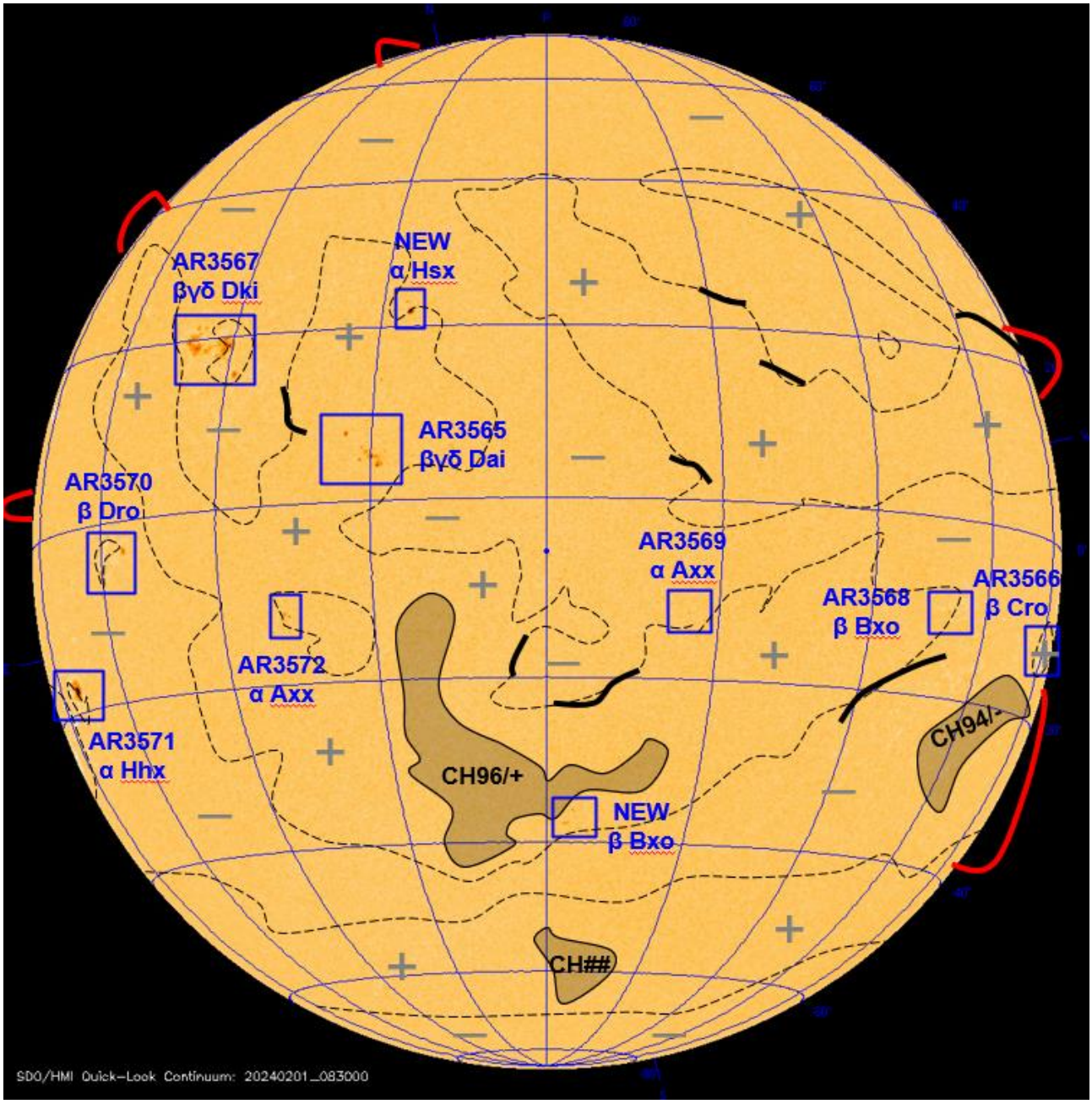
Figure 1. Solar Analysis Valid 01/0830 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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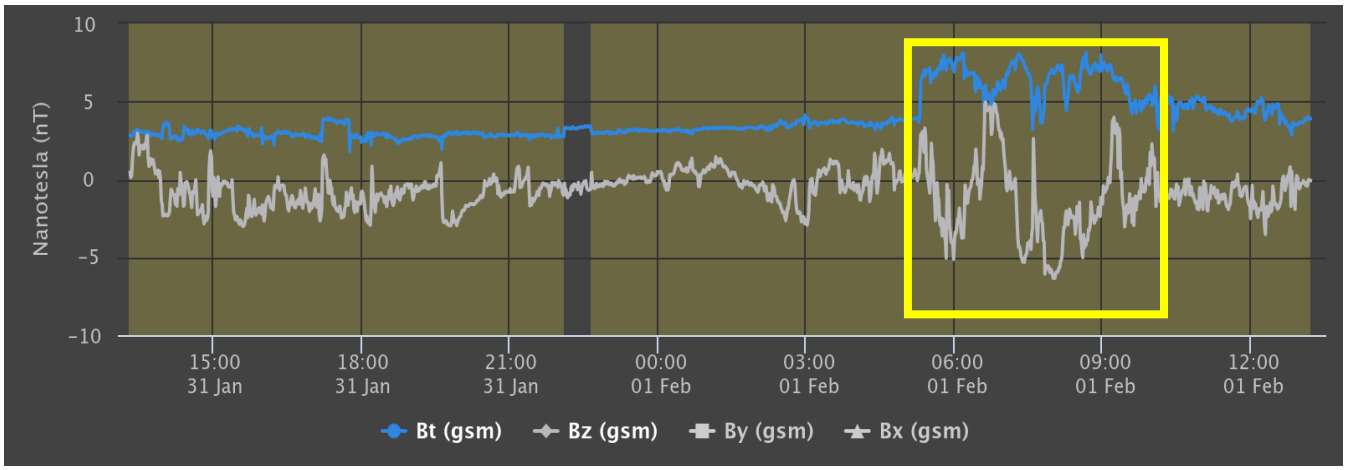
Geomagnetic Storms:

A weak CME arrived at Earth at 01/0520 UTC, which left the Sun on the 29 Jan in association with an M6.8 flare, which originated from Ex-AR3559. Solar winds have been slightly elevated to background, due to the waning effects of coronal hole fast winds, with the source likely CH94/- or CH95/-, before a brief increase back to slightly elevated levels, following the arrival of the aforementioned weak CME. Solar winds are currently declining to background levels.

Figure 2: L1 magnetometer – shows the weak CME (which left the Sun on 29 Jan) arriving at Earth early on 01 Feb (yellow box).



The anticipated next coronal hole enhancement is from CH96/+ in the southern hemisphere. The arrival of the fast wind at Earth may be from late day 3 (03 Feb), though probably more likely on day 4 (04 Feb). This is a recurrent feature and compares well in terms of location and size to the previous rotation. Therefore solar wind speeds may once again peak 450-500 km/s.

Generally Quiet to Unsettled conditions are expected through the period. There is a chance for isolated Active intervals on day 4 (04 Feb), due to the influence of the trailing portion of CH96/+. There is the pending analysis of a CME which left the Sun early on day 1 (01 Feb) in the northern hemisphere for any potential Earth-directed component.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	5	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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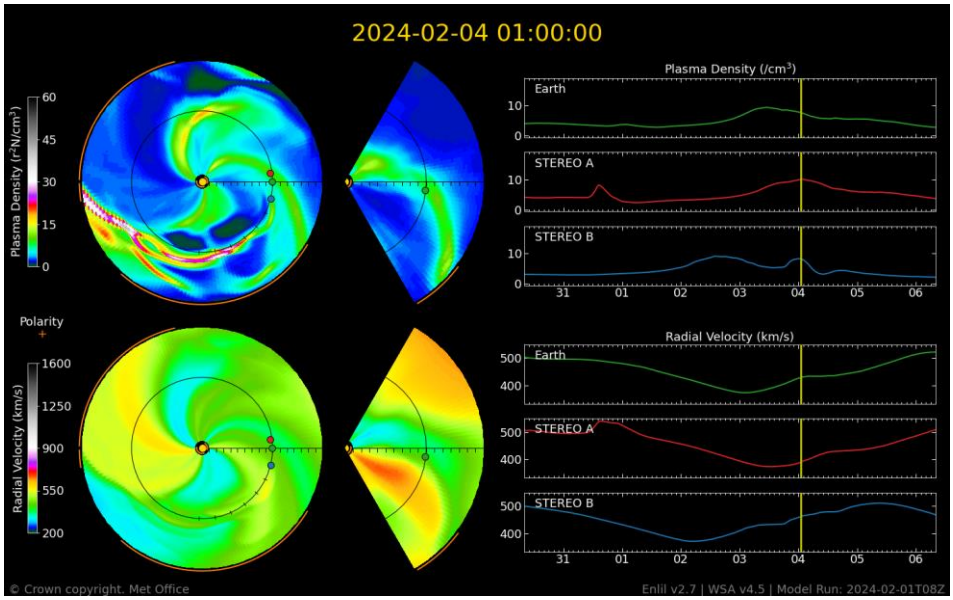
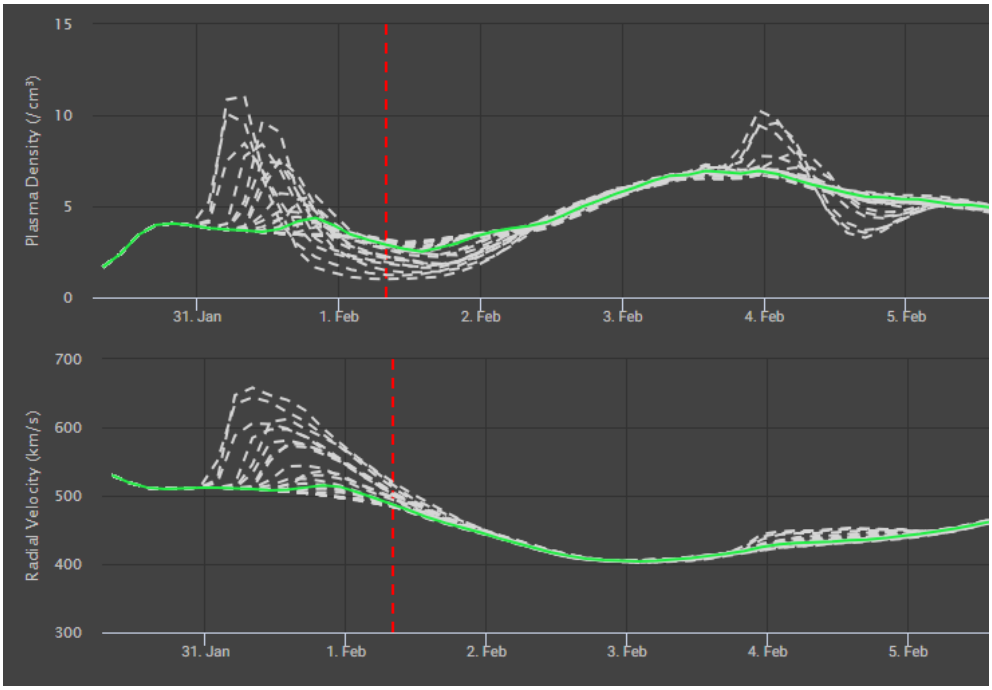
Figure 3: MOSWOC Enlil and Ensemble





Radio Blackouts - X-Ray Flares:

Low activity is expected with a chance of isolated M-class flares increasing activity to Moderate levels. This is most likely from AR3565 or AR3567, both located in the northeast disc.

There are currently ten sunspot regions on the disc, two of which are noteworthy and five of which are yet to be numbered. AR3567 in the northeast remains the largest and most magnetically complex region on the disc, with continued growth whilst maintaining at least one delta spot. AR3565 in the northeast is the only other spot showing some magnetic complexity, it also continues to increase in areal extent and comprises a north-south magnetic alignment in its leading portion, and contains a delta spot. All remaining sunspots appear to be small or in decay, especially in the western hemisphere, with one newly emerging sunspot on the east limb, although difficult to analyse at present due foreshortening.

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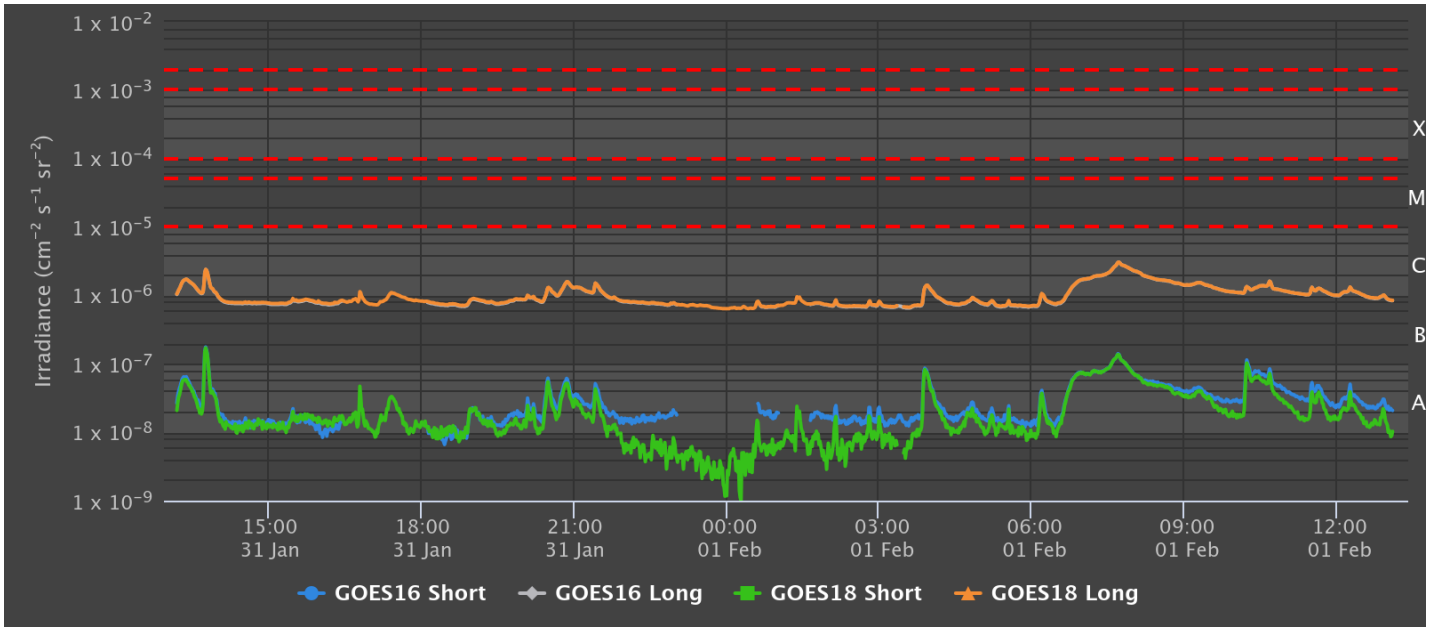
X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	45	45	45	45
Very Active	**R3 to R5 X Class**	No	5	5	5	5

Figure 4: 24-hour X-Ray flare trace.



Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux is currently at slightly elevated levels following the M6.8 flare on 29 Jan from EX-AR3559, but remains below the S1/Minor Storm threshold and continues to slowly fall. The risk of breaching the S1 threshold is now only a Slight Chance, should any notable flares occur from the spots on the visible disk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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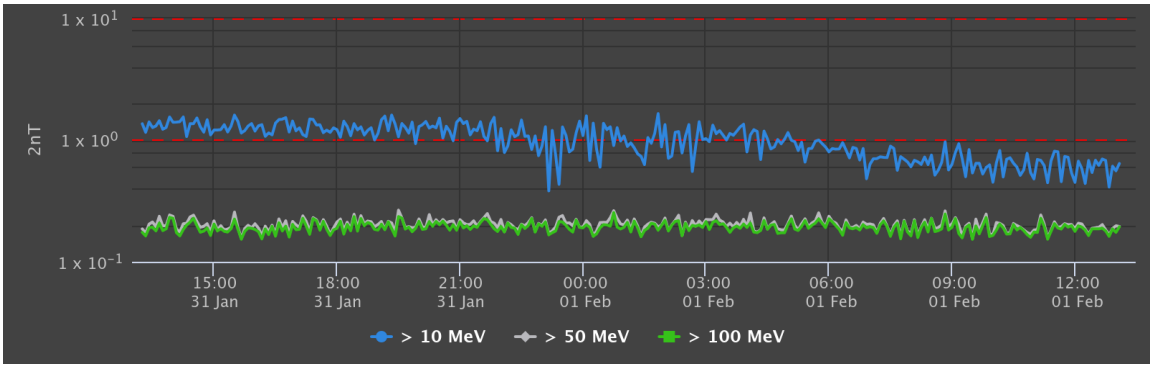
Figure 5: 24-hour high energy proton trace



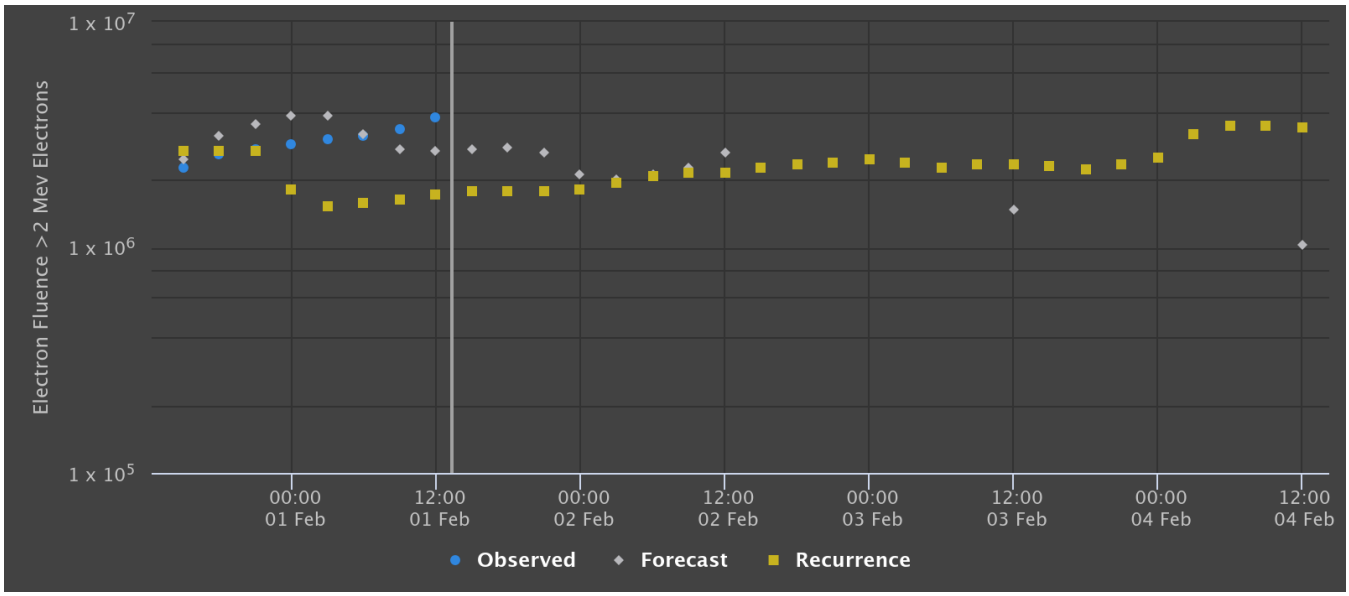
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has spent the whole of the past 27-day rotation below High levels, with an absence of significant drivers to alter this state given the expected lack of potent coronal hole fast winds. Persistence suggesting significant electron flux is very unlikely.

MOSWOC REFM's projections and persistence values both imply a continuation of the current background state, this is considered good guidance.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: MOSWOC REFM electron fluence observations, forecast and recurrence.



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